

Results of the *M/V Kuroshima* Oil Spill Shellfish Tissue Analysis 1999, 2000 and 2004

Report to the M/V Kuroshima Trustee Council

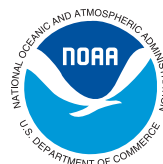
Prepared by

Doug Helton
NOAA Office of Response and Restoration

Adam Moles
Jeff Short
Jeep Rice
NOAA Auke Bay Laboratory

This Restoration Study for the M/V Kuroshima Oil Spill in Summer Bay, Alaska was conducted by the National Oceanic and Atmospheric Administration on behalf of the State and Federal natural resource trustee agencies, and the Qawalangin Tribe of Unalaska.

December 2004



Summary:

Shellfish samples collected in Summer Bay Alaska during the winter of 1997 and spring of 1998 showed evidence of polycyclic aromatic hydrocarbon (PAH) contamination from the *M/V Kuroshima* spill. Archived samples from June 1999, September 2000, and newly acquired samples collected during April 2004 were analyzed by the NMFS Auke Bay, Alaska, Lab during July of 2004. All mussel sampling stations showed substantial declines in contamination to levels well below state and national averages. All but one urchin sampling station showed substantial declines. The one urchin sample station with measurable contamination levels was below levels that would trigger a health concern. Examination of the petroleum fingerprint suggests that the contamination was from marine diesel and was not from the bunker oil carried by the *M/V Kuroshima*.

Introduction:

On November 26, 1997, the *M/V Kuroshima*, a 370-foot refrigerated cargo vessel, broke away from its anchorage in Summer Bay on Unalaska Island, near Dutch Harbor, Alaska. While the vessel was attempting to move to a safer anchorage, winds reported to be in excess of 100 knots blew the freighter into Second Priest Rock, damaging several of the vessel's fuel tanks. The vessel subsequently ran aground on the shore of Summer Bay, spilling 39,000 gallons of Bunker C, a heavy fuel oil. Oil was blown onto Summer Bay Beach and approximately 3.4 miles of marine shorelines were contaminated, including shorelines in Morris and Humpy Coves and Constantine Bay. In addition, a substantial amount of oil flowed into Summer Bay Lake. Over 80% of the lakeshore was impacted by oil and there was substantial accumulation of oil on the Lake bottom. High winds also blew oil on to the dunes and nearby upland areas.

The presence of oil adjacent to shellfish harvesting areas raised questions regarding whether the shellfish were being contaminated. A common measure of oil contamination involves testing for polycyclic aromatic hydrocarbons (PAHs). PAHs are a class of organic compounds found in variety of chemicals, crude and refined fuels, natural seeps, and are a by-product of combustion, including internal combustion engine emissions, cigarette and wood smoke. Mussels, being filter-feeding animals, can pick up PAHs from the water column and are therefore a sensitive indicator of both acute and chronic petroleum contamination. In addition, different types of oils have unique PAH patterns or fingerprints. Chemical analysis can therefore discern both the level of contamination and potentially determine the source of the contamination. Hence, PAHs were selected as the appropriate analytes for the long-term monitoring of Summer Bay shellfish.

Restoration:

In May 2002, Kuroshima Shipping agreed to settle natural resource damage claims and funds were made available for restoration of the injured natural resources. One element of the restoration plan included additional sampling of shellfish from harvesting areas oiled by the *M/V Kuroshima*. The purpose of the sampling was to answer the following questions: 1) do elevated petroleum hydrocarbons exist in mussels and urchins at the spill site compared with reference locations; 2) is that contamination related to the *M/V Kuroshima* Spill? and 3) do the levels exceed limits that may be a concern for consumption? This report focuses on those questions.



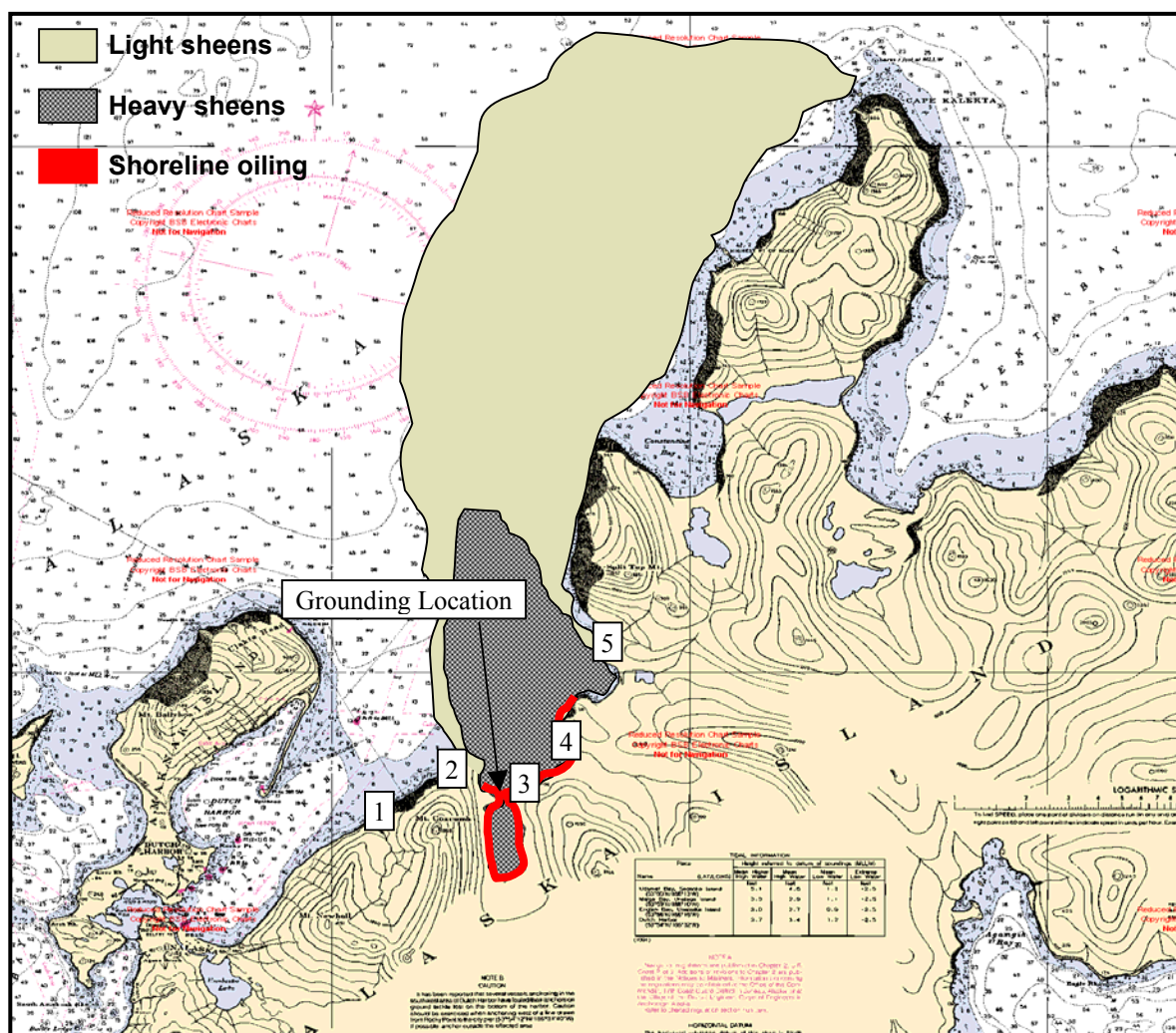


Figure One: Chart of Unalaska Island and the Dutch Harbor region, showing the estimated cumulative oiling footprint derived from multiple overflights and shoreline surveys. Note that on any single day, oil sheens covered a much smaller area. Shellfish sampling stations are also labelled (see table one and two for results).

Results:

This report contains post spill PAH data on tissue samples of mussels (*Mytilus trossulus*) and urchins (*Strongylocentrotus droebachiensis*) collected in several locations near Summer Bay, Alaska. The mussels were collected in 1999, 2000 and 2004, while urchins were collected only in 2004. All samples were submitted to NOAA Auke Bay Laboratory for chemical analyses. All samples were analyzed for the presence of petroleum hydrocarbons using standard protocols and quality assurance procedures (Gas Chromatography-Mass Spectrometry was as the primary analytical tool for PAH). A total of 24 shellfish samples and one archived source oil were analyzed were analyzed for alkanes C10-C34 and polycyclic aromatic hydrocarbons (PAHs).

The results of the post-spill data are compared with existing PAH data from mussel and urchin samples collected in winter and spring during the spill response and cleanup (1997 and 1998). The post-spill samples were collected from the same stations and using the same methods as employed during the spill.

Mussels:

A total of fifteen mussel samples were analyzed from Summer Bay, Humpy Cove, and Morris Cove. The samples were collected during 1999, 2000, and 2004. All mussel samples were near or below background PAH concentrations. The total PAH concentration in all the mussels ranged from 25 to 340 ng/g (parts per billion) dry weight (dw) for all three years of data, but the last year (2004) of sampling found levels between 25 and 85 ng/g dw, with an average of 57 ng/g dw.

Urchins:

A total of nine urchin samples were collected on April 10, 2004 in Summer Bay, Humpy Cove and Morris Cove. Most had very low or undetectable levels, but two samples from Summer Bay Beach had more than 4000 ng/g total PAHs (dry wt.). The TPAH concentrations in these two samples were 4193 and 6164 ng/g. However, the third urchin sample and all of the mussel samples collected on the same day and in that same location had only background PAH levels. Six other urchin samples in Humpy and Morris coves had levels ranging from 0-14 ng/g.

Interpretation of the oiled samples:

All mussel tissues showed small and declining levels of PAH contamination and even the highest total PAH concentration found could be considered background and of no biological significance. The mussels collected in 1999 and 2000 had greater concentrations than the 2004 samples, and the PAH pattern evident in these mussels was faintly consistent with the oil spilled from the *M/V Kuroshima*, considering that most of the individual PAHs analyzed were below detection limits. The 2004 mussel samples had no discernable pattern.

The contamination of the two urchin samples from Summer Bay Beach is somewhat puzzling, especially given the very low levels found in the other stations (5 and 7 ng/gm dw), and the fact that mussels collected at the same time and location had background levels. The Summer Bay Beach station is near the outlet of Summer Bay Lake. Tar balls and tar mats were noted along Summer Lake in 2002, presumably dislodged from the lake bottom by winter storms. The lake bottom and outlet stream may continue to be an intermittent source of contamination of Summer Bay, but at the time of sampling, no visible oil was noted in the intertidal area (Rance Morrison, personal communication). Further analysis of the individual PAHs showed that both urchin samples were dominated by a preponderance of phenanthrenes (67% in both samples), and contained little dibenzothiophenes and no chrysenes. This distribution of PAH is not consistent with the *M/V Kuroshima* spill source oil, even if weathered, or with the pattern that would be found from PAH dissolving from the weathered *M/V Kuroshima* source oil into seawater.



Instead, the pattern is more consistent with a marine diesel fuel, and does not appear to be related to the *M/V Kuroshima* spill.

Discussion:

Mussels are "filter feeders" and actively strain plankton and small particles from the water it pumps through its gills. The mussel's filtering efficiency, combined with the wide-spread distribution of PAHs from chronic sources and very low laboratory detection limits, means that even mussels in "clean" areas will show low levels of contamination. Given that Unalaska is one of the largest fishing ports in North America with hundreds of large fishing vessels and associated ship traffic, the key question is what baseline, or pre-spill levels of PAHs, would be expected had the *M/V Kuroshima* not spilled oil in Summer Bay.

Unfortunately, no pre-spill data was available from Summer Bay for hydrocarbon levels. However, for the past twenty years, the National Oceanic and Atmospheric Administration (NOAA) has tracked coastal contamination trends through the National Mussel Watch Program. A total of 44 PAH compounds are included in the analytical program, and the program has several hundred monitoring stations along the US coastline, including five sites in Alaska¹. The Mussel Watch program, combined with reference stations on the periphery of the spill zone, and samples collected over time, provide a good indication of both peak and background levels. As a result, the PAH levels found in Summer Bay can be placed in both a national, regional, and local context.

Mussel Watch Data:

In 2001, the state-wide average total PAH concentrations in mussels from the five Alaska sites was 86.6 ng/g dw. Levels ranged from 52.5 to 144 ng/g dw. The 2004 sampling in Summer Bay found levels between 25 and 85 ng/g dw, with an average of 57 ng/g dw. Thus, the levels of PAH contamination in Summer Bay mussels is below the state average. In contrast to current levels in Summer Bay, the average PAH concentration in mussels for the remainder of the West Coast is nearly 30 times higher, 1982 ng/g dw. The highest site on the west coast was 46,700 ng/g dw at a site in Elliot Bay near Seattle. The lowest, with 41 ng/g, was from mussels collected on Santa Cruz Island in Southern California. This island is a National Park 20 miles offshore of Santa Barbara. Hence, despite the ship traffic around Dutch Harbor, the PAH levels in Summer Bay appear to be some of the cleanest on the entire west coast.

Reference Stations:

A reference station was set up on the periphery of the spill zone in Morris Cove in an area exposed to little or no known oiling from the *M/V Kuroshima*, and outside of the port zone. Samples collected during the winter after the spill showed that Station Five was the cleanest site, with levels approximately 15 times lower than Summer Bay Beach. However, with an average

¹ The five long-term sites are in Ketchikan, Skagway, Port Valdez, Unakwik Inlet, and Cook Inlet. All sites were selected to be representative of the surrounding area and sites with known point discharges or hot spots, such as fuel docks or outfalls, were avoided in establishment of the stations. Other sites are also monitored in Prince William Sound and Gulf of Alaska using the same methodologies.



PAH level of 713 ng/g, it appears that some oil sheens may have contaminated the site. Sampling conducted at the same station in 2004 found average levels of 32 ng/gm in Morris Cove, the lowest of any site sampled as part of this project, and cleaner than any other mussel watch site in Alaska or the lower 48 states. Hence, 32 ng/gm may be a good benchmark for background exposure.

Temporal Sampling.

The final indication that mussel tissue levels are at background is based on the decline and stabilization of tissue contamination levels at the same station over time (Table 1). Station 3, located on the beach next to the grounding site, was visibly and chemically the most contaminated shoreline. The station has now been sampled 6 times over a seven year time period. Very high levels were found during the spill, but declined rapidly over the following two years. Since June of 1999, levels have stabilized or slowly declined, and are now at or near background levels as indicated by mussel watch and reference site information. It is reasonable to expect slightly higher “background” levels at Station Three since Summer Bay is an anchorage zone for cargo ships and is closer to the port of Dutch Harbor.

Urchin Samples.

There is no equivalent of the mussel watch program for urchins. Urchins are herbivores that feed by grazing on aquatic vegetation. The animals may be exposed to oil through their gills, or through grazing on a contaminated substrate, but are generally thought to be less at risk from oil in the water column than mussel that may filter gallons of water per day. The initial rounds of sampling support this hypothesis, with urchins typically having PAH levels that were 10% to 30% of levels found in mussels. As with mussels, the PAH levels in urchins appear to have declined over time to near detection levels with the exception of station 3. As mentioned above, the samples collected during 2004 appear to have PAHs from a diesel source.

Health Risk Analysis.

No supplementary health risk analysis was conducted using the newly analyzed shellfish data. In 1998, the Alaska Department of Health, in consultation with the US Public Health Service’s Agency for Toxic Substances and Disease Registry (ATSDR) conducted a health risk analysis for intertidal seafood contaminated by the *M/V Kuroshima* oil spill. The consultation was based on PAH data collected in April 1998, and conservatively based the analysis on data from Summer Bay, Station 3, which had the highest PAH levels. The ATSDR concluded that no advisories or closures were warranted. Mussel PAH levels are now 150 times lower than levels found in 1998.

With the exception of the two urchin samples mentioned above, urchin PAH levels are now 90-400 times lower than levels found in 1998. Even the two “hot” samples that show evidence of diesel contamination unrelated to the *M/V Kuroshima* are at levels whereby ATSDR concluded no significant health risk.



Table 1: Mussel Tissue Concentrations² Over Time: Unalaska Bay Stations : ng/g dry weight. (NS= not sampled) All stations are arithmetic mean of 3 or more samples. Each sample composed of approximately 20 mussels.					
Date	Station 1 1 mile West of 2 nd Priest Rock	Station 2 2 nd Priest Rock	Station 3 Summer Bay Beach	Station 4 Humpy Cove	Station 5 Morris Cove
Dec. 1997	NS	NS	74,750	NS	NS
April 1998	1233	1300	10,333	7333	713
June 1998	NS	NS	953	577	NS
June 1999	NS	NS	150	NS	NS
Sept. 2000	NS	NS	309	NS	NS
April 2004	NS	NS	65	75	32
West Coast Average	1982	1982	1982	1982	1982
National Average	1571	1571	1571	1571	1571
Alaska Average	89	89	89	89	89

Table 2: Urchin Tissue Concentrations Over Time: Unalaska Bay Stations : ng/g dry weight. (NS= not sampled) All stations are arithmetic mean of 3 or more samples. Each sample composed of approximately 8-10 urchins.					
Date	Station 1 1 mile West of 2 nd Priest Rock	Station 2 2 nd Priest Rock	Station 3 Summer Bay Beach	Station 4 Humpy Cove	Station 5 Morris Cove
Dec 1997	NS	NS	17333	NS	NS
April 1998	853	590	3450	2200	633
June 1998	NS	NS	NS	NS	NS
June 1999	NS	NS	NS	NS	NS
Sept. 2000	NS	NS	NS	NS	NS
April 2004	NS	NS	3454	5	7

² Alaska and West Coast averages are 2001 data from Appendix 9: *Mussel Contaminants in Science Advisory Panel Report on the Impact of Cruise Ship Wastewater Discharge on Alaska Waters*, Alaska Department of Environmental Conservation, November 2002

